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Distribution of *Alternaria* species among sections. 6. Species formerly assigned to genus *Ulocladium*

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Abstract—Morphological examination of phylogenetically unexamined species of the superseded genus *Ulocladium* allowed for the inclusion of additional species in *Alternaria* sect. *Pseudoulocladium* (2 spp.; total spp. = 6), *A.* sect. *Ulocladioides* (3 spp.; total spp. = 20), and *A.* sect. *Ulocladium* (1 sp.; total spp. = 4). Eight new combinations and four replacement names are established to bring nomenclature in accordance with modern *Alternaria* taxonomy.

Key words—*Alternaria populicola*, *Alternaria preussii*, *Alternaria pseudobotrytis*, *Alternaria sylvestris*

Introduction

Ulocladium was first described by Preuss in 1851. However, the genus was disregarded by taxonomists for more than 100 years until it was resurrected by Simmons (1967). About 30 species have been included in *Ulocladium*.

Recently, all former alternarioid hyphomycetes (13 genera) were transferred to *Alternaria* based on extensive morphological and phylogenetic studies, including the type species of the genus *Ulocladium*, *Alternaria botrytis* (Woudenberg & al. 2013). The expanded *Alternaria* has been divided into 27 taxonomic sections (Lawrence & al. 2016).

The 35 epithets connected with *Ulocladium* represent 32 species, as three epithets are synonyms or orthographic variants of other species names. The

phylogenetic position of 26 species has been unveiled (Runa & al. 2009; Wang & al. 2009, 2010; Lawrence & al. 2013; Woudenberg & al. 2013; Geng & al. 2014). Nineteen former *Ulocladium* species have been distributed among three main sections within the enlarged genus *Alternaria* based on phylogenetic data: *A.* sect. *Pseudoulocladium*, *A.* sect. *Ulocladioides*, and *A.* sect. *Ulocladium*, consisting almost exclusively of former *Ulocladium* species. Two species were connected with other more distant sections: *U. chlamydosporum* Mouch. [≡ *A. mouchaccae* E.G. Simmons] within *A.* sect. *Phragmosporae* and *U. litoreum* Pivkin & Zvereva [≡ *A. litorea* (Pivkin & Zvereva) E.G. Simmons] within *A.* sect. *Infectoriae*. The infrageneric taxonomic position of seven species has not been formalized, and six species remain phylogenetically unexamined.

Alternaria sections *Pseudoulocladium*, *Ulocladioides*, and *Ulocladium* are morphologically similar. However, some minor morphological features (combined with archetypal features) can help determine affiliation of a species with a section of *Alternaria*: *A.* sect. *Pseudoulocladium* conidia are commonly produced in simple or branched chains; members of *A.* sect. *Ulocladioides* usually produce densely geniculate (sharply angled) conidiophores with conidial clusters, conidia sometimes form short chains, and when present, secondary conidiophores are short with several conidiogenous loci; and while morphologically very similar to *A.* sect. *Ulocladioides*, *A.* sect. *Ulocladium* typically produces single conidia or small clusters of conidia with no chains.

This work is a continuation of the series of articles dedicated to the morphological examination of *Alternaria* species that have not been assessed using molecular data. Previous works grouped species with common morphological features into nine sections (Gannibal 2015, 2016, 2018; Gannibal & Lawrence 2017, 2018).

The aims of this work were i) to examine the morphology of phylogenetically unexamined *Ulocladium* species and determine their morphological affiliation with any *Alternaria* section and ii) to formalize the taxonomic status of *Ulocladium* species with defined phylogenetic positions that have not undergone taxonomic revision in order to propose a stable and accepted taxonomy to these unique lineages within the pleomorphic genus *Alternaria*.

Materials & methods

The morphology of almost all *Alternaria* species with legitimate names was analyzed with regard to conformity with criteria of *Alternaria* sect. *Pseudoulocladium*, *A.* sect. *Ulocladioides*, and *A.* sect. *Ulocladium*. We based our morphological assessment on original diagnoses and illustrations (Simmons 1967, Yen 1981, Liu & Zhang 2008, Nagaraju & al. 2009, Shipunov & al. 2009).

Results & discussion

The evaluation of descriptions of six *Ulocladium* species allowed for placement within *Alternaria*. We place two species in *A*. sect. *Pseudoulocladium*, three species in *A*. sect. *Ulocladioides*, and one species in *A*. sect. *Ulocladium*. *Alternaria* species representing the former *Ulocladium* and their sectional *Alternaria* affiliation are listed in Table 1. As a result of this study, *A*. sect. *Pseudoulocladium* now includes six species, *A*. sect. *Ulocladioides* twenty species, and *A*. sect. *Ulocladium* four species.

To bring nomenclature in accordance with modern-day *Alternaria* taxonomy we propose eight new combinations and four replacement names.

Taxonomy

Alternaria allii-tuberosi (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr., **comb. nov.**

MycoBank 822967

≡ *Ulocladium allii-tuberosi* X.G. Zhang & T.Y. Zhang, Mycosystema 25(4): 516. 2006.

Alternaria castaneae (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr., **comb. nov.**

MycoBank 822968

≡ *Ulocladium castaneae* X.G. Zhang & T.Y. Zhang, Mycosystema 25(4): 517. 2006.

Alternaria gpagarwalii (Nagaraju, Kunwar, Manohar. & D.K. Agarwal) Gannibal & D.P. Lawr., **comb. nov.**

MycoBank 822966

≡ *Ulocladium gpagarwalii* Nagaraju, Kunwar, Manohar. & D.K. Agarwal, Indian Phytopathol. 62(2): 237. 2009.

Alternaria manihoticola (J.M. Yen) Gannibal & D.P. Lawr., **comb. nov.**

MycoBank 822970

≡ *Ulocladium manihoticola* J.M. Yen, Bull. Soc. Mycol. France 97(3): 132. 1981.

Alternaria microspora (Moub. & Abdel-Hafez) Gannibal & D.P. Lawr., **comb. nov.**

MycoBank 822971

≡ *Ulocladium microsporum* Moub. & Abdel-Hafez, Trans. Brit. Mycol. Soc. 69(1): 164. 1977.

Alternaria oblongo-obovoidea (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr., **comb. nov.**

MycoBank 822972

≡ *Ulocladium oblongo-obovoideum* X.G. Zhang & T.Y. Zhang, Mycosystema 21(1): 25. 2002.

Alternaria populicola Gannibal & D.P. Lawr., **nom. nov.**

MycoBank 822973

≡ *Ulocladium populi* E.G. Simmons, G. Newc. & A. Shipunov, Persoonia 23: 181. 2009.
non *Alternaria populi* T.Y. Zhang 2003.

Etymology: from the Latin *Populus* (the host plant genus) and *cola* (inhabitor).

Alternaria preussii Gannibal & D.P. Lawr., **nom. nov.**

MycoBank 822974

≡ *Ulocladium dauci* E.G. Simmons, Canad. J. Bot. 76(9): 1538. 1999 ["1998"].
non *Alternaria dauci* (J.G. Kühn) Groves & Skolko 1944.

Etymology: in honour of Carl Gottlieb Traugott Preuss, who described the genus *Ulocladium*.

Alternaria pseudobotrytis Gannibal & D.P. Lawr., **nom. nov.**

MycoBank 822969

≡ *Ulocladium leve* H.M. Liu & T.Y. Zhang, Mycosystema 27(1): 1. 2008.
non *Alternaria levis* Gambogi ex E.G. Simmons 2007.

Etymology: referring to the similarity of the fungus with *Alternaria botrytis*.

Alternaria sorghi (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr., **comb. nov.**

MycoBank 822975

≡ *Ulocladium sorghi* X.G. Zhang & T.Y. Zhang, Mycosystema 25(4): 518. 2006.

Alternaria sylvestris Gannibal & D.P. Lawr., **nom. nov.**

MycoBank 822976

≡ *Ulocladium lignicola* Nagaraju, Kunwar, Manohar. & D.K. Agarwal,
Indian Phytopathol. 62(2): 238. 2009.
non *Alternaria lignicola* (Corda) Fr. 1849.

Etymology: from the Latin *sylva* (forest), vegetation type where the species was first found.

Alternaria zantedeschiae (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr., **comb. nov.**

MycoBank 822977

≡ *Ulocladium zantedeschiae* X.G. Zhang & T.Y. Zhang, Mycosystema 25(4): 519. 2006.

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Table 1. List of *Alternaria* spp. assigned to *A.* sect. *Pseudoulocladium*, *A.* sect. *Ulocladioides*, and *A.* sect. *Ulocladium*.

Alternaria* sect. *Pseudoulocladium

A. aspera Woudenb. & Crous (Woudenberg & al. 2013)
≡ *U. arborescens* E.G. Simmons

A. chartarum Preuss (Runa & al. 2009; Wang & al. 2009, 2010; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *U. chartarum* (Preuss) E.G. Simmons

A. concatenata Woudenb. & Crous (Wang & al. 2009, 2010; Woudenberg & al. 2013)
≡ *U. capsici* F. Xue & X.G. Zhang [as "*capsicuma*"]

A. lanuginosa (Harz) Sacc.
≡ *Stemphylium lanuginosum* Harz
≡ *U. lanuginosum* (Harz) E.G. Simmons

A. septospora (Preuss) Woudenb. & Crous (Runa & al. 2009; Wang & al. 2010; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *Helminthosporium septosporum* Preuss
≡ *U. septosporum* (Preuss) E.G. Simmons

A. sylvestris Gannibal & D.P. Lawr.
≡ *U. lignicola* Nagaraju, Kunwar, Manohar. & D.K. Agarwal

Alternaria* sect. *Ulocladioides

A. allii-tuberosi (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr. (Geng & al. 2014)
≡ *U. allii-tuberosi* X.G. Zhang & T.Y. Zhang

A. atra (Preuss) Woudenb. & Crous (Runa & al. 2009; Wang & al. 2009, 2010; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *U. atrum* Preuss

A. brassicae-pekinensis Woudenb. & Crous (Wang & al. 2010; Woudenberg & al. 2013)
≡ *U. brassicae* Yong Wang bis & X.G. Zhang

A. cantlous (Yong Wang bis & X.G. Zhang) Woudenb. & Crous (Woudenberg & al. 2013; Geng & al. 2014)
≡ *U. cantlous* Yong Wang bis & X.G. Zhang

A. castaneae (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr. (Geng & al. 2014)
≡ *U. castaneae* X.G. Zhang & T.Y. Zhang

A. consortialis (Thüm.) J.W. Groves & S. Hughes (Runa & al. 2009; Wang & al. 2009; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *Macrosporium consortiale* Thüm.
≡ *U. consortiale* (Thüm.) E.G. Simmons

A. cucurbitae Letendre & Roum. (Runa & al. 2009; Wang & al. 2009, 2010; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *U. cucurbitae* (Letendre & Roum.) E.G. Simmons

A. gpagarwalii (Nagaraju, Kunwar, Manohar. & D.K. Agarwal) Gannibal & D.P. Lawr.
≡ *U. gpagarwalii* Nagaraju, Kunwar, Manohar. & D.K. Agarwal

A. heterospora Woudenb. & Crous (Wang & al. 2009; Woudenberg & al. 2013; Geng & al. 2014)
≡ *U. solani* Yong Wang bis & X.G. Zhang

A. microspora (Moub. & Abdel-Hafez) Gannibal & D.P. Lawr. (Geng & al. 2014)
≡ *U. microsporum* Moub. & Abdel-Hafez

A. multiformis (E.G. Simmons) Woudenb. & Crous (Runa & al. 2009; Wang & al. 2009, 2010; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *U. multiforme* E.G. Simmons

A. oblongo-obovoidea (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr. (Geng & al. 2014)
≡ *U. oblongo-obovoideum* X.G. Zhang & T.Y. Zhang

A. obovoidea (E.G. Simmons) Woudenb. & Crous (Runa & al. 2009; Wang & al. 2009, 2010; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *U. obovoideum* E.G. Simmons

A. populicola Gannibal & D.P. Lawr.
≡ *U. populi* E.G. Simmons, G. Newc. & A. Shipunov

A. preussii Gannibal & D.P. Lawr. (Runa & al. 2009; Wang & al. 2009, 2010; Lawrence & al. 2013)
≡ *U. dauci* E.G. Simmons

A. pseudobotrytis Gannibal & D.P. Lawr.
≡ *U. leve* H.M. Liu & T.Y. Zhang

A. sorghi (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr. (Geng & al. 2014)
≡ *U. sorghi* X.G. Zhang & T.Y. Zhang

A. subcucurbitae (Yong Wang bis & X.G. Zhang) Woudenb. & Crous (Wang & al. 2009, 2010; Woudenberg & al. 2013; Geng & al. 2014)
≡ *U. subcucurbitae* Yong Wang bis & X.G. Zhang

A. terricola Woudenb. & Crous (Runa & al. 2009; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *U. tuberculatum* E.G. Simmons

A. zantedeschiae (X.G. Zhang & T.Y. Zhang) Gannibal & D.P. Lawr. (Geng & al. 2014)
≡ *U. zantedeschiae* X.G. Zhang & T.Y. Zhang

Alternaria sect. *Ulocladium*

A. alternariae (Cooke) Woudenb. & Crous (Runa & al. 2009; Woudenberg & al. 2013)
≡ *Sporidesmium alternariae* Cooke
≡ *U. alternariae* (Cooke) E.G. Simmons

A. botrytis (Preuss) Woudenb. & Crous (Woudenberg & al. 2013)
≡ *U. botrytis* Preuss

A. manihoticola (J.M. Yen) Gannibal & D.P. Lawr.
≡ *U. manihoticola* J.M. Yen

A. oudemansii (E.G. Simmons) Woudenb. & Crous (Runa & al. 2009; Woudenberg & al. 2013)
≡ *U. oudemansii* E.G. Simmons

Alternaria sp. [strain CBS 504.74, misidentified as '*A. capsici-annui*' Săvul. & Sandu] (Woudenberg & al. 2013)

Names with bracketed annotations = species with phylogenetic data (in the cited references).
Unannotated names = species assigned to a section of *Alternaria* in this article for the first time.
Names in bold = new combinations or replacement names.

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